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DEFLECTION OF LIGHT BASED ON THE KALUZA–KLEIN THEORY IN THE PRESENCE OF DECAYING DARK ENERGY

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For a proposed model of decaying dark energy the deflection of light in spherically-symmetric static Gross–Perry spacetime and in Kerr–Taub–Bolt spacetime is considered. Estimates are given for the variation of the standard deflection of light in the field of the Sun.

Keywords: fifth dimension, decaying dark energy, variable mass, deflection of a beam of light, metric of spacetime, decay constant.

INTRODUCTION

Previous papers [1, 2] investigated the deflection of light in the presence of a potential function and an electromagnetic field within the framework of Kaluza–Klein theory in the absence of the proposed model of decaying dark energy. In the proposed model, a parameter B^* is defined, which has an influence on the deflection of light: $|B^*| = \mu\lambda/cn$, where λ is the dark energy scale [3], c is the velocity of light, $n = 0.7/0.3$ is the ratio of the density of dark energy Ω_{DE} to the density of dark matter Ω_{DM} in the Universe, μ is the decay constant of the proposed model of dark energy corresponding to the well-known physical mechanism of energy decay via spontaneous decay of *atomic nuclei*: $(dm/dt)/m = -\mu = \text{const}$ is the decay constant, and

$$m / m_0 = e^{-\mu t_i} \tag{1}$$

in the given case of hypothetical quasiparticles held together by gluon forces and entering into a substance oscillating with an initial frequency of 10^{12} Hz [4], their total rest mass is less than the rest mass of the dark energy. The range of the parameter μ depends on the time t_i of spontaneous decay of the particles; toward this end, we estimate μ for a chosen mass ratio [1]:

$$m_k / m_0 = (\rho_{\text{DE}} / \rho_{\text{DE0}})_k (\lambda_k / \lambda^*)^3 = e^{-\mu t_i}, \tag{2}$$

$\mu = -[\ln(\rho_{\text{DE}}/\rho_{\text{DE0}})_k(\lambda_k/\lambda^*)^3]/t_i$. Here, for cosmological time $t_k = 0.961\cdot10^{12}$ s $\rho_{\text{DE}}/\rho_{\text{DE0}} = 0.5727$, $\lambda^* = 0.0085$ cm, and $\lambda_k = 0.0040$ cm [3, 5, 6]; thus, $\mu = 2.8187 / t_i$. For example, for a decaying fermion (τ-lepton) with mass 1776.8 MeV/c^2 [7] the time t_i is equal to $2.9\cdot10^{-13}$ s, and $\mu = 9.7\cdot10^{12}$; for the top-quark model, the time t_i is equal to $\approx 5\cdot10^{-25}$ s; thus $\mu \approx 5.6\cdot10^{24}$. In the general case of the interaction time for spontaneous and induced decay, the constant μ should probably be determined from the results of experiments at CERN and by observers on the Spektr–Rentgen–Gamma orbital observatory, and also by theoretical studies. Next, from [3], taking the parameter n into account, by definition we write

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